

Adsorption of sulfur dioxide on volcanic ashes

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ABSTRACT

The adsorption of pure sulfur dioxide gas on volcanic ashes has been studied from 0.1 mbar to 1 bar and from -80 to $+150$ °C. Finely ground synthetic glasses of andesitic, dacitic, and rhyolitic composition served as proxies for fresh natural ash surfaces. Powders from two natural obsidian samples were also studied and yielded results broadly similar to the synthetic model systems. SO₂ adsorption on ash is partially irreversible; it appears that the first layer of SO₂ molecules adsorbed on the surface cannot be removed. The pressure and temperature dependence of adsorption can be described by the equation $\ln c = A T^{-1} + B \ln P + C$, where c is the surface concentration of adsorbed SO₂ in mg/m², T is temperature in Kelvin, and P is the partial pressure of SO₂ in mbar. A multiple regression analysis of the experimental data yielded $A = 1645$, $B = 0.29$, $C = -7.43$ for andesite, $A = 2140$, $B = 0.29$, $C = -9.32$ for dacite, and $A = 910$, $B = 0.21$, $C = -4.48$ for rhyolite. These data imply that adsorption strongly decreases with temperature, but only slowly decreases with decreasing partial pressure of SO₂. Therefore, adsorption primarily occurs in the cool and diluted parts of the volcanic plume. Model calculations show that most of the SO₂ may be removed from the plume, if the initial SO₂ concentration in the volcanic gases is low and the surface area of the ash is high. For high initial SO₂ concentrations, the fraction of SO₂ that is lost by adsorption decreases, since the amount of SO₂ in the gas phase is proportional to the SO₂ partial pressure P , while adsorption is proportional only to $P^{0.2} - P^{0.3}$. Adsorption of SO₂ on ash particles may therefore be one reason why the climatic impact of explosive volcanic eruptions does not always scale with total sulfur yield.

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